"characteristic function" of Massieu, the "force function for constant temperature" of Gibbs, and the "thermodynamic potential" of Duhem. All these names represent the same function, $F$ (or $-F$), the integral energy ($U$) less the product of the absolute temperature ($T$) into the entropy ($S$); or in symbols the free energy $F = U - TS$. In the above-mentioned researches it is shown that a system will be in stable equilibrium if the free energy is a minimum. Hence, to restate Mr. Pickering's conclusion, it follows that, in any complex system of atoms or molecules, where two or more arrangements are independently possible, then the final arrangement will be such that its formation is attended with the greatest loss of "free energy." Although this work has now been published nearly fifteen years, so far as I am aware no serious attempt has been made to prove it to be inaccurate.

Let the energy, entropy, and temperature before the reaction be $U$, $S$, and $T$; after the equilibrium is established, $U'$, $S'$, and $T'$, then $(F - F') = (U - U') - (TS - T'S')$. But $(F - F')$ must be positive, *i.e.* $(F - F') > 0$. If the temperature be so low that the second term is small compared to the first, then there will be loss of energy—an evolution of heat. But this is not the only possible case; the reaction may take place with an absorption of heat if $T'S' > TS$, and also $(TS - T'S') > (F - F')$. Here $(U - U')$ is essentially negative; in other words, the reaction will take place of itself and with absorption of heat. This will account for many apparent anomalies in high temperature reactions.

Further, as regards the statement that "no amount of heating can make an endothermic reaction possible so long as it remains endothermic," we see from the equation $F = U - TS$ that the importance of the second term increases with the temperature, and thus $F$ may decrease by the increase in $TS$ as well as by the more generally recognized decrease in $U$. $U$ may, in fact, increase in the course of the reaction, provided that the corresponding increase in $TS$ is larger.

Exception might also be taken to the definition given of chemical affinity as "the potential energy possessed by atoms." It is rather difficult to imagine potential energy becoming "satisfied" when the atoms combine together. As, however, there are now several works giving a complete account of the other views on this subject, it is unnecessary to discuss this point.

In conclusion, it may be as well to point out that the above remarks contain nothing new, having been known for years; but as they have not yet found their way into the text-books of thermal chemistry, and are apparently ignored by our leading thermo-chemists, it seems worth while to bring them to the notice of students. GEORGE N. HUNTLY.

Richmond, Surrey, December 22, 1890.

## Forestry in North America.

THE timber-cutters, graziers, and settlers, who are rapidly destroying the forests of North America have recently obtained a valuable ally in Major J. W. Powell, Director of the United States Geological Survey; who, in his enthusiasm for the construction of dams, appears to care little from whence his countrymen are to get their future supplies of timber, whilst his proposed means for securing to them a perpetual water-supply for irrigating the farm lands below the Rocky Mountains, when confronted with the experience acquired in Europe, are likely to prove worse than useless. Most students of physical geography consider hill forests as efficient aids in storing water, but not so Major Powell; for in the April number of the *Century Magazine* in a paper on the "Non-irrigable Lands of the West," and in another paper published in the August number of the *North American Review*, entitled "The Lesson of Conemaugh," he advocates the denudation of the higher slopes of the Rocky Mountains, in order to allow snow-drifts to accumulate in the folds of the hills, and afford a perennial supply of water for irrigating the drier lands below the forest belt. Major Powell contends that, as long as the higher hill slopes remain forest-clad, the snow falling on them will always be uniformly distributed, and cannot be drifted together by the wind. It therefore melts away gradually, without affording a steady supply of water to the hill streams. He also asserts that in California the hill streams have increased wherever the hills have been denuded; and expresses his opinion that, although forests may be useful in districts with a heavy rainfall, as they evaporate excessive moisture rapidly from the soil, yet in drier regions this rapid evaporation is prejudicial, and therefore forests should be cleared in order to preserve the requisite amount of moisture in the soil. This appears to be a complete inversion of what actually occurs, as I hope to show further on.

Major Powell gives a most striking picture of the ease with which forest denudation may be effected in the dry coniferous forests of the Rocky Mountains. When camping out twenty years ago in this magnificent forest tract, where the growth was then so dense that not a blade of grass was to be found under the trees, but the soil was completely covered with dead needles; the Major allowed his camp fire to ignite a splendid pine tree, and watched the "welcome flame" rising till the whole tree was in a blaze. The fire soon spread to the surrounding forests, and before nightfall the country for miles around was in flames, more timber being destroyed in a few days than "has been used by the people of Colorado for the last ten years."

Major Powell, however, as we have stated, would preserve forests in the damper regions, and admitting the danger of forest fires to their existence, he proposes as a remedy a great extension of sheep-farming; so that the undergrowth of the forests may be nibbled off, and thus a great source of danger from fire may be removed. What the sheep are to find to nibble in forests where the soil is covered with dead needles, it is not easy to say; and if all undergrowth be bitten off by the sheep, the future re-growth of the forest could evidently not be assured by natural seedlings, but the older portions must be gradually fenced and planted up: if this be done on a large scale it is to be feared that even the vast resources of the States would prove inadequate. An answer has, however, already appeared in an American periodical, *Alta California*, to the Major's suggestions regretting the progress of forest arson, and anticipating that thousands of acres of the noblest timber in the world will be destroyed before the first rains next autumn. The writer states that these forest fires are chiefly due to shepherds, who burn the pine needles, and consequently the entire forest, in order to get young grass to spring up for their flocks.

So much for the real results of extending sheep-runs to preserve the forest from fire, which reminds one of a suggestion in Prof. Wallace's "Indian Agriculture"; except that this author goes further than Major Powell, and wishes to induce the Government of India to put an end to the efforts of the Indian Forest Department to protect their forests from fire, considering that Indian forest trees have grown up under a *régime* of annual fires till they have become quite inured to them, and would suffer if the fires were stopped. The Professor also urges that the Indian flocks and herds would miss the fresh young grass always springing up in burned forest, but if admitted to graze in the annually burned area, would keep down the undergrowth, the occasional burning of which in a forest protected from fire, according to him, does more damage than annual fires in well-grazed forests. It is to be feared that both the Edinburgh Professor of Agriculture and the Director of the United States Geological Survey have more sympathy for the shepherds than for the forests.

Besides the paper controverting the Major's advocacy of sheep as friends to the forest, I was glad to see two very sensible articles, in *Garden and Forest* of June 18 and September 4, entirely opposed to his theories, whilst Mr. Abbot Kenney has written a paper in the August number of the *Century* showing that the statement about the increase in volume of the hill streams in California being due to forest denudation, is at variance with the facts of the case.

There can be no doubt that directors of geological surveys should study the action of the forest as a great natural factor influencing soil and climate. In Germany, the elements of forestry are taught in primary schools as a necessary part of the general education of the country people; but the German peasants have owned forests, and participated in their benefits, for centuries, and a forest fire in France or Germany is considered a great calamity by the whole country-side: the Anglo-Saxon race on the contrary has been chiefly engaged during the last 300 years in clearing away the virgin forests of the new worlds in the western and southern hemispheres; and, as we see, the benefits of forests are still questioned by certain influential people both here and in America.

Darwin and A. R. Wallace admit over and over again the inestimable value of the forest as Nature's great conservative force; and in America, Major Powell's heresies were long ago disposed of in Marsh's "Man and Nature." In Wallace's

© 1891 Nature Publishing Group

"Tropical Nature," we read as follows:—"A systematic planting of all hill-tops, elevated ridges, and higher slopes, would probably cure the bad effects of the intermittent rainfall of Central India; whilst the action of forests in checking evaporation from the soil, and in causing perennial springs to flow which may be collected in reservoirs, would serve to fertilize a great extent of country."

Major Powell evidently disagrees with the results of Wallace's observations, but the facts are quite opposed to his theories. Forests do not evaporate moisture nearly so fast as bare ground; and although denuded hill-sides may favour the accumulation of snow-drifts, yet they allow the rainfall to drain off rapidly, and cause dangerous floods; loosening of the soil on hill-sides; avalanches; silting up of river-beds; and frequently give rise to the complete devastation of cultivable lands at the foot of the hills, as the material washed down from above is spread over them by the floods in the form of silt, gravel, and boulders.

In Dr. Schlich's "Manual of Forestry," at pp. 43 *et seq.*, we read that experience in Germany shows evaporation from forests to be only two-fifths of that in the open country, and that the balance of water retained in forest soil increases rapidly with the altitude, so that evaporation in mountain forests may be reduced to about 10 per cent. of the rainfall. We also know that, in France and Germany, mountain forests have long been looked upon as preservers of moisture and feeders of springs. In 1889, the French Government spent 3,192,800 francs in *reboisement* works in the Alps, Pyrenees, and Auvergne; and this almost entirely for the indirect benefits resulting from forests to the mountains, as the plantations and embankments which form the *reboisement* works are too costly ever to yield a direct revenue commensurate with the heavy expenditure incurred in such remote and inaccessible places. If, however, Major Powell's proposed denudation of the Rocky Mountains were to be effected, besides its disastrous indirect results, America would suffer from a greatly curtailed supply of timber to meet the ever-increasing demands of a vast continent, which cannot depend on any adequate supply from abroad. We see that in the McKinley Act the Government of the United States already acknowledges its own short supply by withdrawing all import duties from Canadian timber; and it is for Canada to assure its own future prosperity by establishing a State forest service to prevent the exhaustion of the Canadian forests, now that they are likely to be fully utilized.

Up to the present time, the Forest Department of the United States has been chiefly occupied in collecting forest statistics and encouraging private planting, but what is really required is to induce each State in the Union to establish a practical control of its own still existing forests.

The Americans have recently refused to join in a postal confederation of English-speaking countries, on the ground that they are now to a large extent German-speaking as well; it is a pity, therefore, that they do not listen to the warnings of the German forester, Dr. Mayer, who has studied the forests of the Rocky Mountains and has given the last word of German scientific opinion on the utter absence of a State forest policy in the United States, in his recently published work on the forest trees of North America.

W. R. Fisher.

Cooper's Hill College.

### Throwing-Sticks and Canoes in New Guinea.

I have just received here my copy of the February number of vol. xix. of the Journal of the Anthropological Institute, in which I have read, with the greatest interest and appreciation, the long and valuable account of the western tribe of Torres Strait, by Prof. Haddon. With regard to the throwing-sticks, of which, on p. 332, he says, "the heavy spears of South-east New Guinea are hurled by a throwing-stick which differs from any Australian implement," I think some error must have been made by his informant. I never saw a throwing-stick in existence, or in use, during my three years' residence in the country, either in the interior, along the south-eastern peninsula, in the Louisiade Archipelago, or on the northern coast as far as Mitre Rock. If these implements do exist on the southern side, they must be very rare. The first spear-thrower from New Guinea brought to England, as far as I am aware, was, nevertheless, the one brought home by me in 1888, which is now in the British Museum. It came, however, from the German possessions on the north-east coast, either from Finch-haven, or from the Augusta River, if I recollect correctly, and was given to me in Cooktown.

In the same paper, on p. 384, occurs this passage with regard to canoes:—"I was much puzzled when I first went to Torres Straits by occasionally seeing a canoe with a single outrigger. I afterwards found that it belonged to a Kanaker from Ware [? Mare], one of the New Hebrides, residing at Mabuiag, and that he had outrigged a native canoe according to the fashion of his own people. When I was at Mabuiag, some natives of that island were fitting up a canoe in imitation of this one, and with a single outrigger. Here a foreign custom is being imitated." The bulk of the large canoes seen on the south-eastern coast at Motu-Motu, Port Moresby, Kerepunu, and in Milne Gulf, have no outriggers at all; while along the coast in small canoes, and in both large and small in the Louisiade Archipelago, the single outrigger is the prevailing form. It is the canoe indigenous to the region, and is undoubtedly not an introduced or imitated custom. The single outrigger in Torres Strait may be an imitation, but it is also a true New Guinea model.

Henry O. Forbes.

Canterbury Museum, Christchurch, New Zealand,
October 29, 1890.

### Pectination.

I have been somewhat disappointed to find that no one can suggest a better explanation of the pectination of birds' claws than that which I gave in Nature of December 4, 1890 (p. 103). As this is the case, however, perhaps I may be permitted to add a remark to what I then said. It has been pointed out to me by a friend that the lateral position of the serration is not so disadvantageous for scratching purposes as I had imagined. While gladly admitting this—which removes a difficulty from the explanation—I still think that my observations must not be taken as conclusive.

It would be most useful and interesting if an observer could be found to give time and attention to representatives of the different orders of birds which possess this peculiarity.

E. B. Titchener.

Inselstrasse 13, Leipzig, January 7.

### The Flight of Larks.

The extraordinary flight of larks to which the Rev. E. C. Spicer refers was observed at Bournemouth. The birds appeared to come across the Channel in thousands, and in a few days had entirely disappeared. There were certainly some fieldfares among them.

Alfred W. Bennett.

## *PROFESSOR VIRCHOW ON THE CONSUMPTION CURE.*[1]

The important communication made by the renowned German pathologist at the last meeting of the Berlin Medical Society is a severe shock to the opinions of those who expect that Koch's mysterious lymph will prove applicable in every case of consumption. Prof. Virchow gives the result of his observations on twenty-one cases that have died, after treatment with the lymph, up to the end of December. Since then, six or seven other cases have come under his notice, but have not yet been completely examined. Of the twenty-one cases, sixteen were phthisical. The remaining five included a case of joint tuberculosis; a case in which lung tuberculosis was accompanied with carcinoma of the pancreas; another had empyema; the next had pernicious anæmia, slight changes in the lungs, and tuberculous pleuritis; and, lastly, comes a case of tubercular inflammation of the arachnoid.

It appears, from an examination of these cases, that the lymph has an action on tuberculosis of internal organs similar to that which it has already been seen to exert on external portions of the body similarly affected. The signs of an intense irritation, such as redness and swelling, are very generally to be met with. An excellent example of this action is afforded by the above-mentioned

---

[1] Reported in the *Berliner klinische Wochenschrift*, January 12, 1890, p. 4[illegible]

© 1891 Nature Publishing Group